Detection and diagnosis of cervical cancer in Pap smear cell images using hybrid CNN

E. K. Arulkarthick[1,*] and P. Sukumar[2]

[1]Department of Electronics and Communication Engineering.

[2]Department of Computer Science and Engineering, Nandha Engineering College, Erode 638 052, India.

Cervical cancer is screened in women patients using either Pap smear cell testing or the Cervigram analysis method. The most dominant accuracy has been obtained for the cervical cancer earlier detection system through the analysis of Pap smear cell images. In this article, they are automatically classified using the proposed hybrid convolutional neural networks (HCNN) structure. This classification system consists of enhancement, along with data augmentation and classification with the nucleus segmentation. The adaptive histogram equalisation enhancement algorithm enhances the image as a preprocessing method, and the imaging count is increased using the data augmentation method for obtaining a higher classification rate. The data-augmented images are further classified into four cases (normal, dysplasia, carcinoma *in situ* (*CiS*) and superficial) using the proposed hybrid CNN structure. Then, the dilation–erosion method was used to obtain the abnormal pixels in classified Pap smear cell images. Further, the morphological features are computed from the segmented nucleus region and are classified into either 'moderate' or 'severe' based on the computed features. The average diagnosis rate for dysplasia cell images is 90.4%. The average diagnosis rate for dysplasia cell images is 94.2%, and the average diagnosis rate for dysplasia cell images is 89.6%. From these extensive experimental results, the proposed methods are more suitable for a fully automated cervical cancer detection system.

Keywords: CNN, data augmentation, enhancement, morphological features, Pap smear.

the abnormal regions in the human body. Therefore, it is hard to identify cancer which does not show any significant symptoms at the initial and middle stages of the cancer development process[1–3]. The cancer in the cervix region of women is known as cervical cancer, and it has three stages of symptoms: mild, moderate and severe. Every woman aged between 21 and 60 must undergo a cervical screening every six months to identify the severity level in its early stage. Cervical cancer can be detected only in moderate and severe stages of its progression. Hence, its early detection is important to save the lives of women patients. It is possible by scanning and examining the cervigram images or by examining the cell images. In the present study, Pap smear cell images are used to detect and segment the cancer region of pixels[4–7]. The linear-shaped nucleolus belongs to the category of normal (Figure 1 *a*), and the non-linear-shaped nucleolus in Pap smear cells belongs to the category of abnormal. The abnormal Pap smear cells are further categorised into three different cases as dysplasia (Figure 1 *b*), carcinoma *in situ* (*CiS*) (Figure 1 *c*) and superficial (Figure 1 *d*) depending on the shape of the images.

Cervical cancer can be screened using the traditional cervigram analysis method, with assistance in large population countries such as India and China, which require a longer detection or screening period. This delays the screening output, and the entire screening procedure is expensive due to the lack of well-trained and experienced cytologists. The women patients who are suffering from cervical cancer are unaware of the importance of early screening of the cervix region. This increases the death rate. This motivated us to bring this research work to fully automate the cervical cancer detection methods using the computer-aided approaches without radiologist assistance.